Table of Contents

Syngas production via methane steam reforming with oxygen: plasma reactors versus chemical reactors.

Accession number & update
7072064, A2001-23-5275R-004; 20011022.
Author(s)
Cormier-J-M; Rusu-I.
Author affiliation
GREMI, Orleans Univ, France.
Source
Future of Technological Plasmas, Brighton, UK, 19-21 March 2001.
In: Journal-of-Physics-D (Applied Physics)(UK), vol.34, no.18, p.2798-803, 21 Sept. 2001.
CODEN
JPAPBE.
ISSN
ISSN: 0022-3727, CCCC: 0022-3727/2001/182798+06 ($30.00).
Availability
SICI: 0022-3727(20010921)34:18L.2798:SPMS; 1-W
Electronic Journal Document Number: S0022-3727(01)23229-X.
Publication year
2001.
Language
EN.
Publication type
CPP Conference Paper, J Journal Paper.
Treatment codes
P Practical.
Abstract
Steam reforming with oxygen (SRO) is a combination of non-catalytic partial oxidation and steam reforming of methane, industrially used for syngas production. There are several models of the chemical reactors used for this purpose but in the last decade a new direction has developed-plasma devices. The aim of the present paper is to make a comparative analysis between the ***autothermal reformers,*** including their improved variants, and the plasma reactors. The study is conceived in terms of advantages and disadvantages coming from the exploitation parameters, methane conversion, selectivity, energy efficiency and investment costs. Although SRO by means of chemical reactors may be the most efficient, plasma reactors represent an incisive approach by their simplicity, compactness and low price. (54 refs).
Descriptors
chemical-energy-conversion; chemical-technology; hydrogen-economy; plasma-materials-processing; steam.
Keywords
syngas production; methane steam reforming with oxygen; ***autothermal reformers;*** plasma reactors; chemical reactors; energy efficiency.
Classification codes
A5275R (Plasma applications in manufacturing and materials
processing).
A8630Q (Chemical energy conversion).

A8640K (Hydrogen storage and technology).

Hydrogen generation from biogenic and fossil fuels by *autothermal* reforming.

Accession number & update
6607560, A2000–13–8630G–057, B2000–07–8255–013; 20000601.

Author(s)
Rampe–T; Heinzel–A; Vogel–B.

Author affiliation
Fraunhofer–Inst fur Solare Energiesyst, Freiburg, Germany.

Source
Sixth Grove Fuel Cell Symposium Fuel Cells – The Competitive Option for Sustainable Energy Supply, London, UK, 13–16 Sept. 1999.
In: Journal–of–Power–Sources (Switzerland), vol.86, no.1–2, p.536–41, March 2000.

CODEN
JPSODZ.

ISSN
ISSN: 0378–7753, CCCC: 0378–7753/2000/ ($20.00).

Availability
SICI: 0378–7753(200003)86:1/2L.536:HGFB; 1–#
Electronic Journal Document Number: S0378–7753(99)00465–6.

Publication year
2000.

Language
EN.

Publication type
CPP Conference Paper, J Journal Paper.

Treatment codes
X Experimental.

Abstract
Hydrogen generation for fuel cell systems by reforming technologies from various fuels is one of the main fields of investigation of the Fraunhofer ISE. Suitable fuels are, on the one hand, gaseous hydrocarbons like methane, propane but also, on the other hand, liquid hydrocarbons like gasoline and alcohols, e.g., ethanol as biogenic fuel. The goal is to develop compact systems for generation of hydrogen from fuel being suitable for small–scale membrane fuel cells. The most recent work is related to reforming according to the ***autothermal*** principle–fuel, air and steam is supplied to the reactor. Possible applications of such small–scale ***autothermal reformers*** are mobile systems and also miniature fuel cell as cogeneration plant for decentralised electricity and heat generation. For small stand–alone systems without a connection to the natural gas grid liquid gas, a mixture of propane and butane is an appropriate fuel. (1 refs).

Descriptors
cogeneration; fuel; fuel–cell–power–plants; hydrogen–economy; proton–exchange–membrane–fuel–cells.

Keywords
hydrogen generation; biogenic fuels; fossil fuels; ***autothermal*** reforming; fuel cell systems; reforming technologies; gaseous hydrocarbons; liquid hydrocarbons; small scale membrane fuel cells; cogeneration plant; decentralised electricity heat generation; stand alone generation systems; PEM fuel cells.

Classification codes
A8630G (Fuel cells).
A8640K (Hydrogen storage and technology).
A8610B (Fossil and other fuels).

B8255 (Fuel cell power plants).
B8410G (Fuel cells).
B8210 (Energy resources).

Syngas and electricity production by an integrated *autothermal* reforming/molten carbonate fuel cell system.

Accession number & update
6185779, A1999-08-8630G-004, B1999-04-8410G-017; 19990301.

Author(s)
Cavallaro-S; Freni-S.

Author affiliation
Dipt di Chimica Ind, Messina Univ, Italy.

Source
Journal-of-Power-Sources (Switzerland), vol.76, no.2, p.190-6, 1 Dec. 1998. , Published: Elsevier.

CODEN
JPSODZ.

ISSN
ISSN: 0378-7753, CCCC: 0378-7753/98/ ($19.00).

Availability
SICI: 0378-7753(19981201)76:2L.190:SEPI; 1-7
Electronic Journal Document Number: S0378-7753(98)00165-7.

Publication year
1998.

Language
EN.

Publication type
J Journal Paper.

Treatment codes
T Theoretical or Mathematical; X Experimental.

Abstract
The feasibility and the overall process economy of an integrated system of molten carbonate fuel cell (MCFC) and ***autothermal reformer*** (ATR) have been studied. The ATR-MCFC performance has been evaluated in terms of pressure, inlet rates of oxygen and steam, current density and cell configuration (indirect or direct). The process, carried out close to the MCFC basic conditions (T=923 K), can be alternatively addressed to the main production of syngas or electricity by means of the inlet operative parameters that strongly influence the outlet composition and the overall thermal balance. A better heat compensation (but a small syngas/electricity production) corresponds to a greater oxygen content in the inlet stream (O/sub 2//H/sub 2/O/CH /sub 4/=0.6/2/6/1), while the H/sub 2/ residual is a complex function of the current density and of the O/sub 2//H/sub 2/O/CH/sub 4/ relative ratios. A total gases pressure in the ATR compartment higher as that into the anodic housing can be hypothesised for a direct ATR-MCFC equipped with a ceramic membrane that strongly improves the cell performance. (22 refs).

Descriptors
current-density; electrochemistry; membranes; molten-carbonate-fuel-cells.

Keywords
molten carbonate fuel cell; ***autothermal reformer;*** MCFC; feasibility; process economy; electrochemical performance; current density; syngas production; electricity production; ceramic membrane; 923 K.

Classification codes

A8630G (Fuel cells).
A8245 (Electrochemistry and electrophoresis).
A8265F (Film and membrane processes; ion exchange; dialysis; osmosis, electro–osmosis).
B8410G (Fuel cells).

Numerical indexing
temperature: 9.23E+02 K.

Copyright statement

Evaluation of hybrid THR–ATR fuel processor.

Accession number & update
1882531, A82062474, B82039297; 820000.

Author(s)
Minet–R–G; Warren–D; Bett–J.

Source
Electr. Power Res. Inst., Palo Alto, CA, USA, Oct. 1981, 76 pp.

ISSN
Report: EPRI–EM–2096.

Availability
Available from: Res. Rep. Center, Box 50490, Palo Alto, CA 94303, USA.

Publication year
1981.

Language
EN.

Publication type
R Report.

Treatment codes
X Experimental.

Abstract
Describes a study of sulfur–tolerant catalysts for processing No.2 fuel oil, and results are presented of tests carried out on the Toyo T–12 and T–12/T–48 combination catalyst at conditions representative of a high–temperature steam ***reformer*** with secondary ***autothermal reformer*** integrated with phosphoric acid fuel cells. The basis of experimental work and analysis, a description of the test program, and a discussion of the test results are included.

Descriptors
catalysts; fuel–cells; power–plants; sulphur.

Keywords
S tolerant catalysts; Toyo T12; Toyo T48; steam ***reformers;*** power plants; tests; catalyst; fuel cells.

Classification codes
```
A8630G    (Fuel cells).
B8260     (Other power stations and plants).
B8410G    (Fuel cells).
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Search strategy

No.	Database	Search term	Info added since	Results
1	INZZ	E3624.CC.	unrestricted	273
2	INZZ	1 AND temperature	unrestricted	34
3	INZZ	temperature–control.DE.	unrestricted	8396
4	INZZ	chemical–reactors.DE.	unrestricted	380
5	INZZ	steam.DE.	unrestricted	15126
6	INZZ	coal–gasification.DE.	unrestricted	693
7	INZZ	fuel–processing–industries.DE.	unrestricted	69
8	INZZ	A8265J.CC.	unrestricted	23391
9	INZZ	7 AND temperature	unrestricted	15
~~10~~	~~INZZ~~	~~7 AND temperature~~	~~unrestricted~~	~~15~~
11	INZZ	1 AND 8	unrestricted	2
12	INZZ	6 AND temperature	unrestricted	156
13	INZZ	4 AND thermowell	unrestricted	0
14	INZZ	5 AND thermowell	unrestricted	2
15	INZZ	12 AND thermowell	unrestricted	0
16	INZZ	(6 OR 7) AND thermowell	unrestricted	0
17	INZZ	9 OR 11 OR 14	unrestricted	18
18	INZZ	autothermal ADJ REFORMER$1	unrestricted	7
19	INZZ	catalysts.DE.	unrestricted	6704
20	INZZ	fuel.DE.	unrestricted	42394

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Control of natural gas catalytic partial oxidation for hydrogen generation in fuel cell applications.

Accession number & update
8261422, C2005-03-3310E-003; 20050130.
Author(s)
Pukrushpan-J-T; Stefanopoulou-A-G; Varigonda-S; Pedersen-L-M; Ghosh-S; Huei-Peng.
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Dept of Mech Eng, Kasetsart Univ, Bangkok, Thailand.
Source
IEEE-Transactions-on-Control-Systems-Technology (USA), vol.13, no.1, p.3-14, Jan. 2005. , Published: IEEE.
CODEN
IETTE2.
ISSN
ISSN: 1063-6536, CCCC: 1063-6536/ ($20.00).
Availability
SICI: 1063-6536(200501)13:1L.3:CNCP; 1-1.
Publication year
2005.
Language
EN.
Publication type
J Journal Paper.
Treatment codes
P Practical; T Theoretical or Mathematical.
Abstract
A fuel processor that reforms natural gas to hydrogen-rich mixture to feed the anode field of fuel cell stack is considered. The first reactor that generates the majority of the hydrogen in the fuel processor is based on catalytic partial oxidation of the methane in the natural gas. We present a model-based control analysis and design for a fuel processing system (FPS) that manages natural gas flow and humidified atmospheric air flow in order to regulate 1) the amount of hydrogen in the fuel cell anode and 2) the ***temperature*** of the catalytic partial oxidation reactor during transient power demands from the fuel cell. Linear feedback analysis and design is used to identify the limitation of a decentralized controller and the benefit of a multivariable controller. Further analysis unveils the critical controller cross coupling term that contributes to the superior performance of the multivariable controller. (24 refs).
Descriptors
anodes; catalysis; chemical-reactors; control-system-analysis; control-system-synthesis; decentralised-control; feedback; flow-control; fuel-cells; ***fuel-processing-industries;*** hydrogen-economy; identification; multivariable-control-systems; natural-gas-technology; oxidation; process-control; ***temperature-control.***
Keywords
natural gas; hydrogen generation; fuel cell applications; fuel processor; anode field; methane; model based control analysis; fuel processing system; humidified atmospheric air flow; catalytic partial oxidation reactor; transient power demand; linear feedback analysis; decentralized controller; multivariable controller.
Classification codes
C3310E (Control applications in mining, oil and natural gas

technology).
C1340B (Multivariable control systems).
C1310 (Control system analysis and synthesis methods).
C1220 (Simulation, modelling and identification).
C3120T (Level, flow and volume control).
C3120N (Thermal variables control).
E3624 (Fuel processing industry).
E1525 (Industrial processes).
E1550 (Control technology and theory).

Digital object identifier
http://dx.doi.org/10.1109/TCST.2004.833649.

The feasibility of a coal gasifier combined with a *high-temperature* fuel cell.

Accession number & update
8192202, A2005-01-8630Q-001, B2005-01-8410G-035; 20041130.

Author(s)
Kivisaari-T; Bjornbom-P; Sylwan-C; Jacquinot-B; Jansen-D; de-Groot-A.
Author affiliation
Dept of Chem Eng, Kungl Tekniska Hogskolan, Stockholm, Sweden.

Source
Chemical-Engineering-Journal (Switzerland), vol.100, no.1-3, p.167-80, 15 July 2004. , Published: Elsevier.
CODEN
CMEJAJ.
ISSN
ISSN: 1385-8947, CCCC: 1385-8947/04/ ($30.00).
Availability
SICI: 1385-8947(20040715)100:1/3L.167:FCGC; 1-I.
Publication year
2004.
Language
EN.
Publication type
J Journal Paper.
Treatment codes
P Practical; T Theoretical or Mathematical.

Abstract
The purpose of the study presented in this paper was to find out the feasibility of integrating a 50 MW fuel cell system, fed by gas from a coal gasifier, with an existing network for distribution of heat and power. The work presented is the results of the technical evaluation of a 50 MW coal fired ***high-temperature*** fuel cell power plant. The overall system can be divided into four subsystems including: coal gasification, gas cleaning, power generation and heat recovery. The final system, a entrained flow gasifier combined with standard low- ***temperature*** gas cleanup and SOFC, resulted in an overall electrical efficiency of about 47%, and an overall efficiency close to 85%. (40 refs).

Descriptors
coal-gasification; fuel-cell-power-plants; ***fuel-processing-industries;*** heat-recovery; molten-carbonate-fuel-cells; solid-oxide-fuel-cells.
Keywords

coal gasifier feasibility; high ***temperature*** fuel cell; integrating fuel cell system; heat distribution; power distribution; coal fired high ***temperature*** fuel cell power plant; coal gasification; gas cleaning; power generation; heat recovery; low ***temperature*** gas cleanup; solid oxide fuel cell; SOFC; molten carbonate fuel cell; MCFC; electrical efficiency; high ***temperature*** fuel cell; flow gasifier; 50 MW.

Classification codes

A8630Q (Chemical energy conversion).
A8630G (Fuel cells).
A8610Z (Other topics in energy resources).
B8410G (Fuel cells).
B8255 (Fuel cell power plants).
B8230G (Combined cycle power stations and plants).
E3624 (Fuel processing industry).

Numerical indexing

power: 5.0E+07 W.

Copyright statement

Digital object identifier

http://dx.doi.org/10.1016/j.cej.2003.12.005.

Cogeneration of power and hydrogen with integrated fuel processor counterpressure *steam* cycles.

Accession number & update

8076500, B2004–10–8230E–004; 20040829.

Author(s)

Spazzafumo–G.

Author affiliation

Dept of Ind Eng, Univ of Cassino, Italy.

Source

International–Journal–of–Hydrogen–Energy (UK), vol.29, no.11, p.1147–50, Sept. 2004. , Published: Elsevier.

CODEN

IJHEDX.

ISSN

ISSN: 0360–3199, CCCC: 0360–3199/04/ ($30.00).

Availability

SICI: 0360–3199(200409)29:11L.1147:CPHW; 1–Z.

Publication year

2004.

Language

EN.

Publication type

J Journal Paper.

Treatment codes

P Practical.

Abstract

The concept of the cogeneration of power and hydrogen plants is introduced with specific regard to the fossil fuels. Fossil fuels require ***steam*** to be converted into hydrogen, while power plants usually discharge heat by condensing ***steam.*** Moreover, hydrogen can be burned with oxygen to produce ***steam*** and to generate power in high– ***temperature steam*** cycles. These considerations suggest that an integration of the processes could result in a very high efficiency of conversion. It would allow the efficient conversion of fossil fuels to power and clean hydrogen. Some theoretical evaluations are carried out which show that an improvement of efficiency

could be reached with respect to separate plants. However, it is necessary to investigate each specific case in order to evaluate the real advantage obtained. (5 refs).

Descriptors

boilers; cogeneration; fossil-fuels; ***fuel-processing-industries;*** hydrogen-economy; oxygen.

Keywords

power hydrogen cogeneration; integrated fuel processor counterpressure ***steam*** cycles; ***steam*** power plants; fossil fuels; generation efficiency; hydrogen energy; hydrogen oxygen cycles; H2.

Classification codes

B8230E (***Steam*** power stations and plants).
B8210 (Energy resources).
E3624 (Fuel processing industry).

Chemical indexing

H2 el, H el.

Copyright statement

Digital object identifier

http://dx.doi.org/10.1016/i.ijhydene.2003.11.001.

	Remove	Document ID	Image Document ID	Source	Page#	Comment
1	☐	US 20040020124 A1	US 20040020124	US-PGPub Full	1	Temperature control is important, because if the temperature rises too much, methanation, hydrogen oxidation, or a reverse shift reaction can occur.
2	☐	US 20030211025 A1	US 20030211025	US-PGPub Full	1	In the fuel processor, air is combined with anode waste gas or a fuel stream and burned in a burner zone to recover or provide heat to reforming zones which undergo endothermic reactions in the presence of steam to convert at least a portion of the feedstock to hydrogen and carbon monoxide.
3	☐	US 6001243 A	US 6001243	US Full	1	In an alternate embodiment, a temperature measuring device 158 is coupled to the oxidant controller 159. The temperature measuring device 158 is adapted to measure the temperature of the reaction products stream (for instance, a thermowell and electronic thermometer may be installed in the effluent stream). The oxidant controller 159 is preferably operable to change the flow rate of the oxidant into the second conduit as a function of the temperature of the reaction products stream. For instance, the oxidant flow rate may be decreased as the reaction products stream increases, and vice versa.
4	☐	US 6001243 A	US 6001243	US Full	6	In an alternate embodiment, a temperature measuring device 158 is coupled to the oxidant controller 159.
5	☐	US 5858311 A	US 5858311	US Full	17	(Empty)
6	☐	US 5858311 A	US 5858311	US Full	19	(Empty)
7	☐	US 3969078 A	US 3969078	US Full	1	Although the reaction zone temperature may be sensed internally, through the use of a suitable thermowell, a more convenient locus is the reaction zone effluent conduit as close to the reaction vessel as possible. This temperature will be virtually the same as the maximum temperature experienced in the reaction vessel as a result of the exothermicity of the alkylation reactions.
8	☐	US 3741713 A	US 3741713	US Full	1	Claims Text - CLTX (10): 7. The flare system as in claim 1 in which said temperature sensing means is mounted inside of a thermowell which passes through the sidewall of said stack. Current US Cross Reference Classification - CCXR (1): 422/109
9	☐	US 20030208960 A1	US 20030208960	US-PGPub Full	1	[0009] More recently, partial oxidation processes have been disclosed in which the hydrocarbon gas is contacted with the oxygen-containing gas at high space velocities in the presence of a catalyst such as a metal deposited on a ceramic foam monolith support. The monolith supports are impregnated with a noble metal such as platinum, palladium or rhodium, or other transition metals such as nickel, cobalt, chromium and the like. Typically, these monolith supports are prepared from solid refractory or ceramic materials such as alumina, zirconia, magnesia and the like.
10	☐	US 20030208960 A1	US 20030208960	US-PGPub Full	2	[0024] Turning now to FIG. 1, line 20 provides ingress into hydrocarbon conversion reactor means A. Typically, the hydrocarbon conversion reactor means include catalytic steam reforming, autothermal catalytic reforming, catalytic partial oxidation processes and non-catalytic partial oxidation processes. The hydrocarbon stream, steam and the optional oxygen containing gas stream will react within the hydrocarbon conversion reactor means at temperatures of approximately 700.degree. C. to about 1300.degree. C.
11	☐	US 20030208960 A1	US 20030208960	US-PGPub Full	5	The reaction temperature was measured with a thermocouple located between the downstream radiation shield and the catalytic monolith.
12	☐	US 2383729 A	US 2383729	US Full	1	(Empty)

6333011 B1 5mm or 8mm diam Thermowell embedded in catalyst (Axial)

	Remove	Document ID	Image Document ID	Source	Page#	Comment
1	☐	WO 9202794 A	WO 9202794 A1	Foreign Full	1	(Empty)
2	☐	US 3913058 A	US 3913058	US Full	1	FIG. 5, in which 1' represents a hot junction of the thermocouple, 7 a protective insulating tube surrounding the thermocouple, 5 a compensating conductor connected to an element 3 of the thermocouple, 9 a metal fitting, 12 a ceramic coating layer and 13 a catalyst layer. -- also teaches ART RECOGNIZED Equivalent temperature sensor of a THERMISTOR
3	☐	US 20040208229 A1	US 20040208229	US-PGPub Full	1	Instant application
4	☐	EP 1469291 A	EP 1469291 A1	Foreign Full	1	EP 1469291A has same priority document
5	☐	US 6576158 B1	US 6576158	US Full	1	common Inventor and assignee
6	☐	US 3891467 A	US 3891467	US Full	1	{of the prior art} carbon deposits on the elements caused by the catalytic property of nickel to crack gas -- Purpose here is to Prevent oxidation and reaction with fuel.
7	☐	US 5005986 A	US 5005986	US Full	1	NAJJAR US 5005986 A US-CL-CURRENT: 374/179, 136/230 , 136/234 , 374/125 , 374/139 , 374/208 , 420/463 , 420/505
8	☐	US 5245100 A	US 5245100	US Full	1	(Empty)
9	☐	US 5245100 A	US 5245100	US Full	2	The transfer of the acid catalyst is thereby mentioned as an increase of temperature at inlet end 3 measured through thermocouple 26 arranged in inlet end 3.
10	☐	US 5595719 A	US 5595719	US Full	1	To determine the steam reforming activity of the catalysts a stainless steel reactor tube of 8 mm inner diameter was used. The reactor was placed in an electric furnace. Inside the reactor tube a thermocouple was positioned at the bottom of the catalyst bed. The thermocouple was attached to a furnace controller and to a digital temperature indicator.
11	☐	US 6453889 B1	US 6453889	US Full	1	(Empty)
12	☐	JP 2004317516 A	JP 2004317516 A	Foreign Full	1	Same Priority Document as instant application
13	☐	US 5192132 A	US 5192132	US Full	1	US 5192132 A See Search -- US-CL-CURRENT: 374/166, 136/230 , 374/179 , 436/147
14	☐	US 2383729 A	US 2383729	US Full	1	US 2383729 A Catalyst chamber apparatus has thermocouple in the catalyst bed... US-CL-CURRENT: 422/211, 374/148 , 422/223 , 422/234
15	☐	DE 3613501 A	DE 3613501 A1	Foreign Full	1	(Empty)
16	☐	US 5232517 A	US 5232517	US Full	1	US 5232517 A See class 136 search US-CL-CURRENT: 136/233, 136/211 , 136/221 , 136/222 , 136/230 , 136/231 , 374/179 , 374/208
17	☐	US 20010055560 A1	US 20010055560	US-PGPub Full	2	The temperature was controlled externally and monitored by a thermocouple on the reactor outside the center of the catalyst bed.